FIG. 1

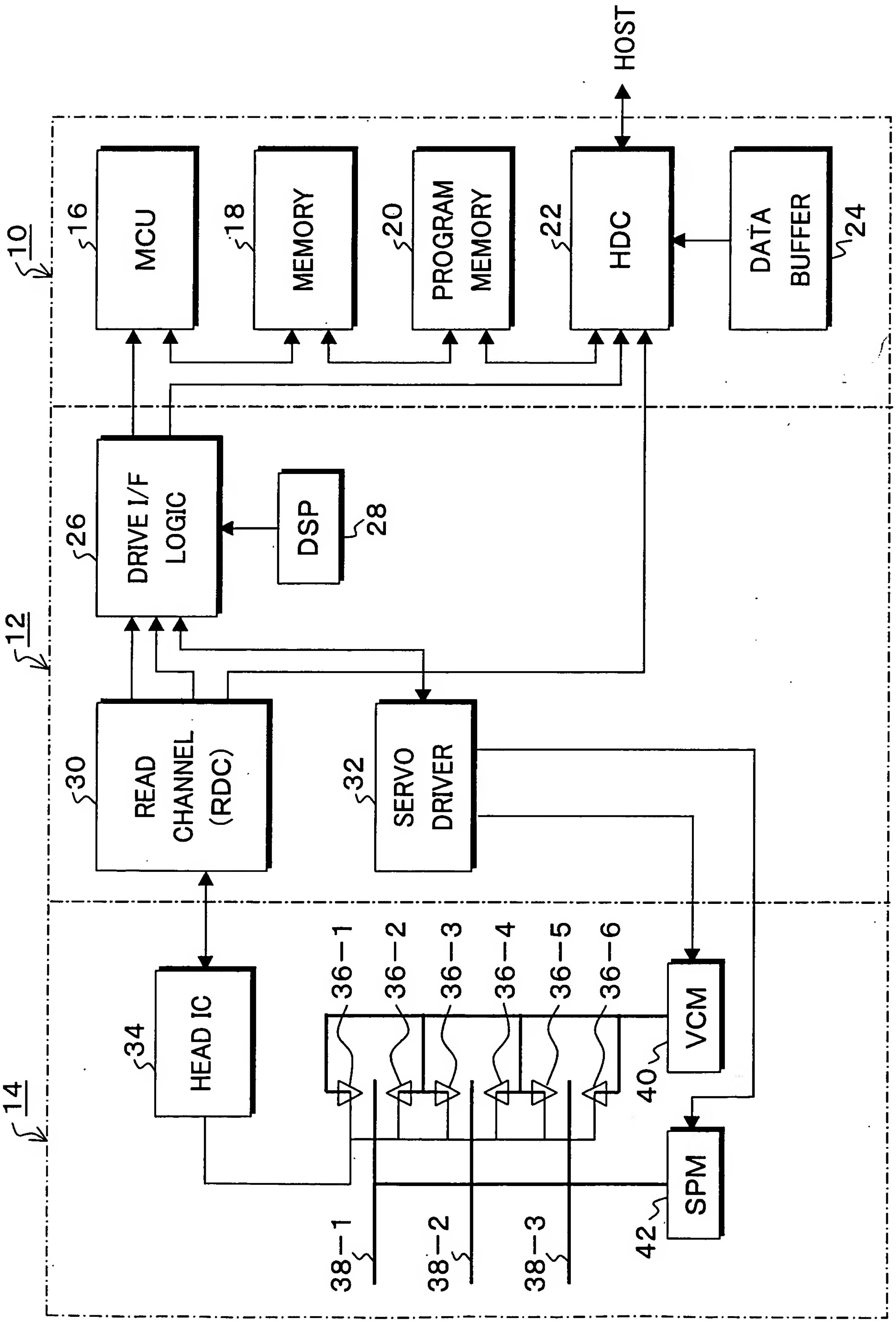

HOST
10
16
MCU
18
MEMORY
20
PROGRAM MEMORY
22
HDC
DATA BUFFER
24
12
26
DRIVE I/F LOGIC
DSP
28
30
READ CHANNEL (RDC)
32
SERVO DRIVER
14
34
HEAD IC
36−1
36−2
36−3
36−4
36−5
36−6
VCM
40
SPM
42
38−1
38−2
38−3

FIG. 2

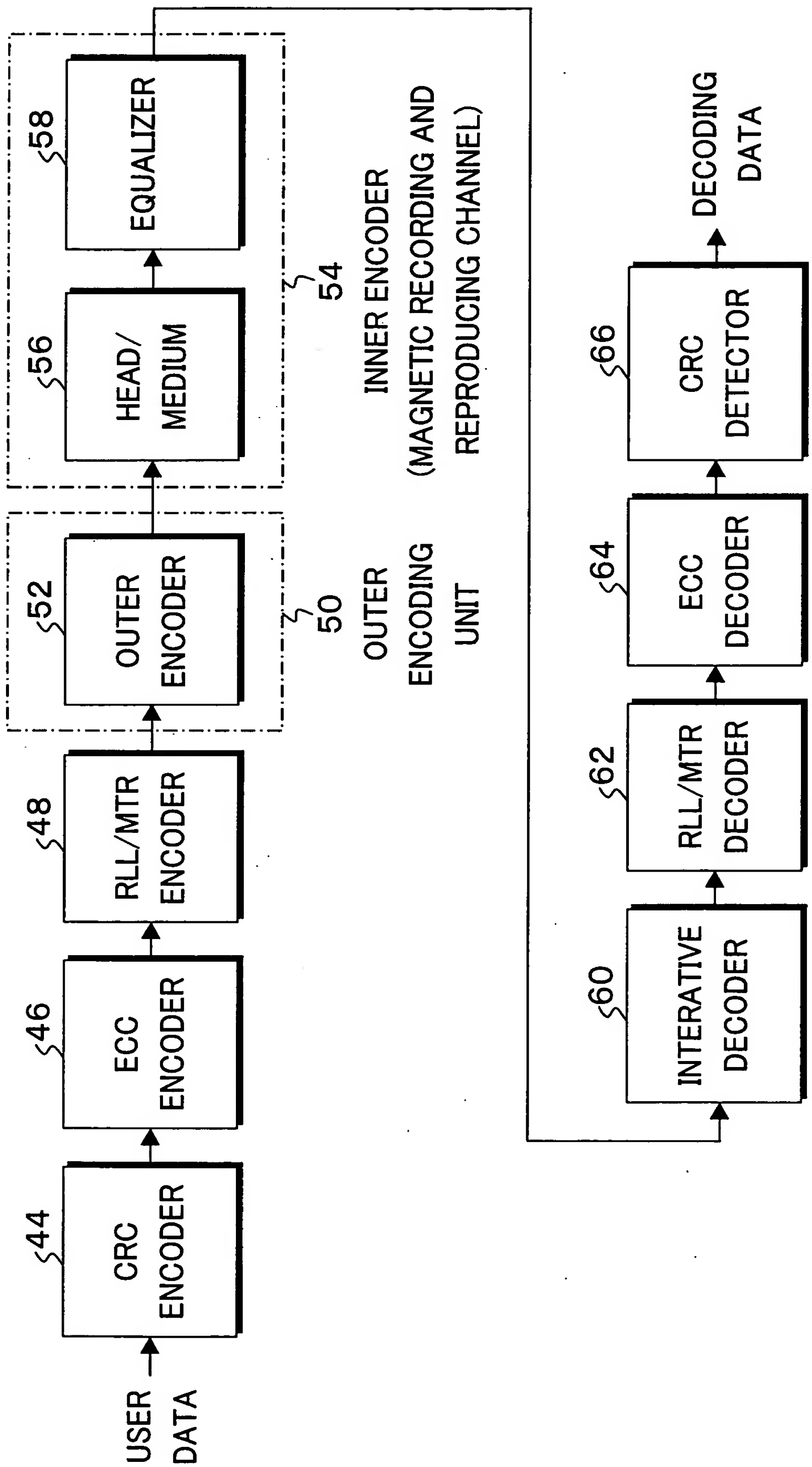

USER DATA
44
CRC ENCODER
46
ECC ENCODER
48
RLL/MTR ENCODER
52
OUTER ENCODER
50
OUTER ENCODING UNIT
56
HEAD/ MEDIUM
58
EQUALIZER
54
INNER ENCODER (MAGNETIC RECORDING AND REPRODUCING CHANNEL)
60
INTERATIVE DECODER
62
RLL/MTR DECODER
64
ECC DECODER
66
CRC DETECTOR
DECODING DATA

FIG. 3

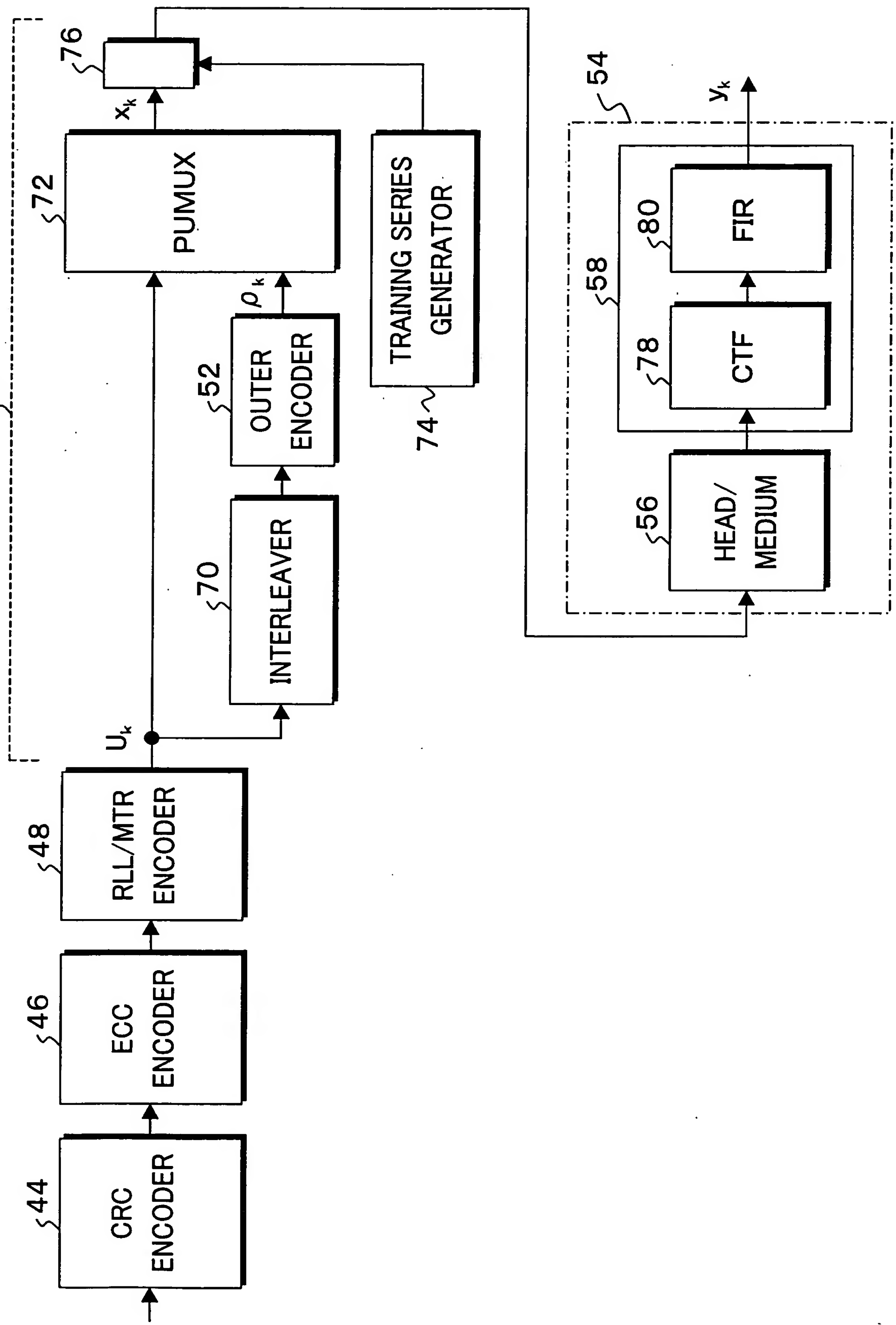

CRC ENCODER
44
ECC ENCODER
46
RLL/MTR ENCODER
48
U_k
52
INTERLEAVER
70
OUTER ENCODER
52
ρ_k
PUMUX
72
x_k
76
TRAINING SERIES GENERATOR
74
HEAD/ MEDIUM
56
CTF
78
FIR
80
58
54
y_k

FIG. 4A

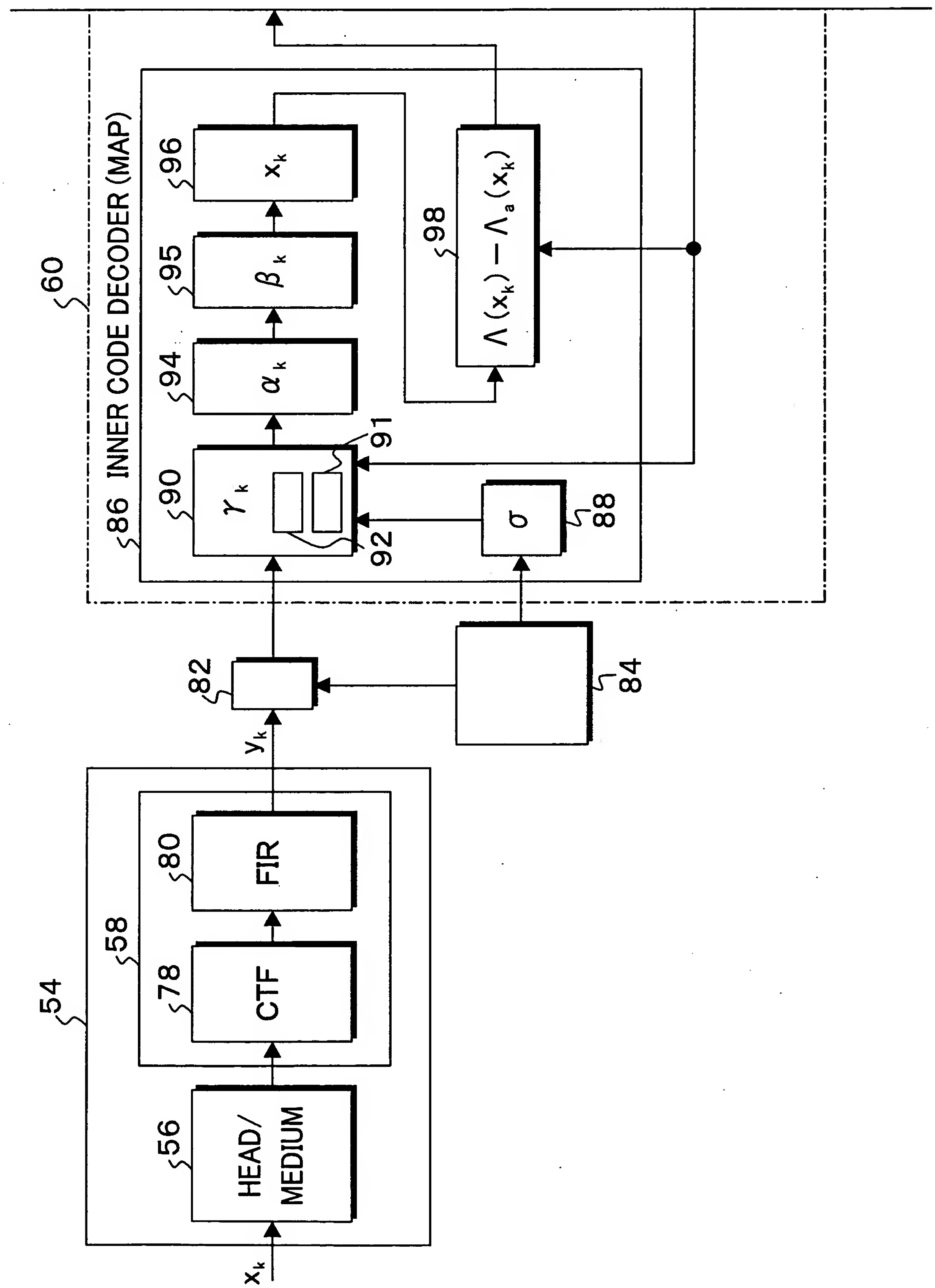

x_k
54
56
HEAD/ MEDIUM
58
78
CTF
80
FIR
y_k
82
84
60
86 INNER CODE DECODER (MAP)
90
γ_k
91
92
94
α_k
95
β_k
96
x_k
88
σ
98
$\Lambda(x_k) - \Lambda_a(x_k)$

FIG. 4B

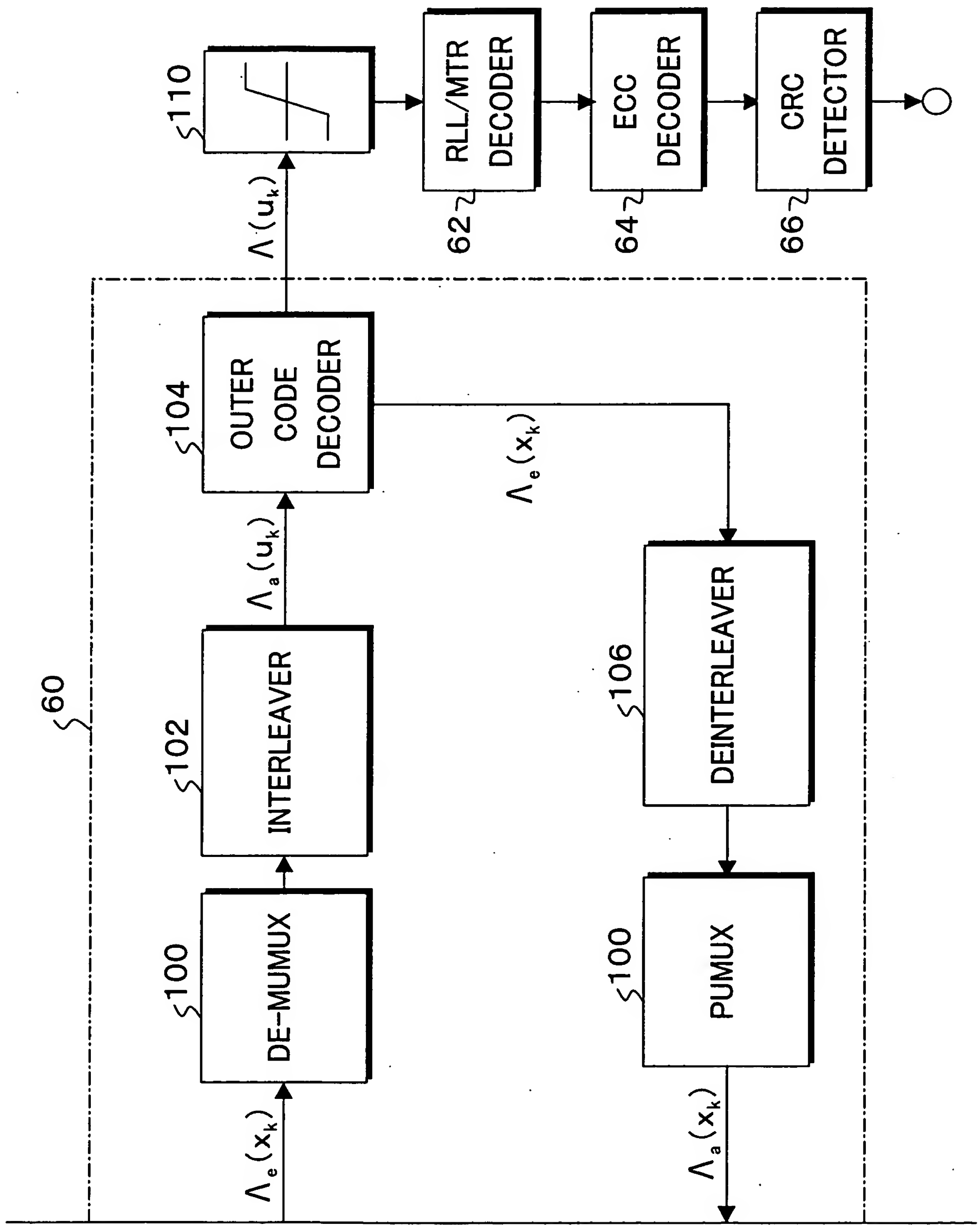

60
$\Lambda_e(x_k)$
100
DE-MUMUX
102
INTERLEAVER
$\Lambda_a(u_k)$
104
OUTER CODE DECODER
$\Lambda(u_k)$
110
RLL/MTR DECODER
62
ECC DECODER
64
CRC DETECTOR
66
$\Lambda_e(x_k)$
106
DEINTERLEAVER
100
PUMUX
$\Lambda_a(x_k)$

FIG. 5

$x_{k-1}x_k$	S_0
00	S_1
01	S_2
10	S_3
11	S_4

FIG. 6

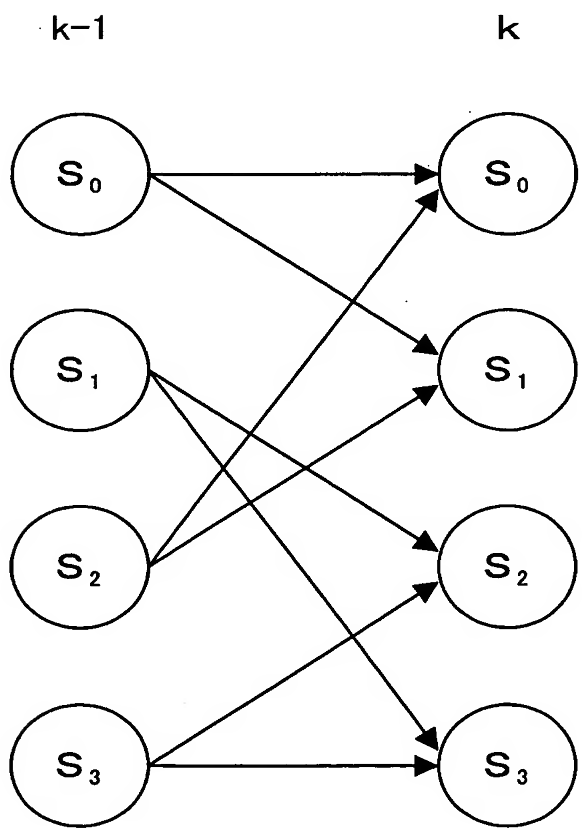


FIG. 7

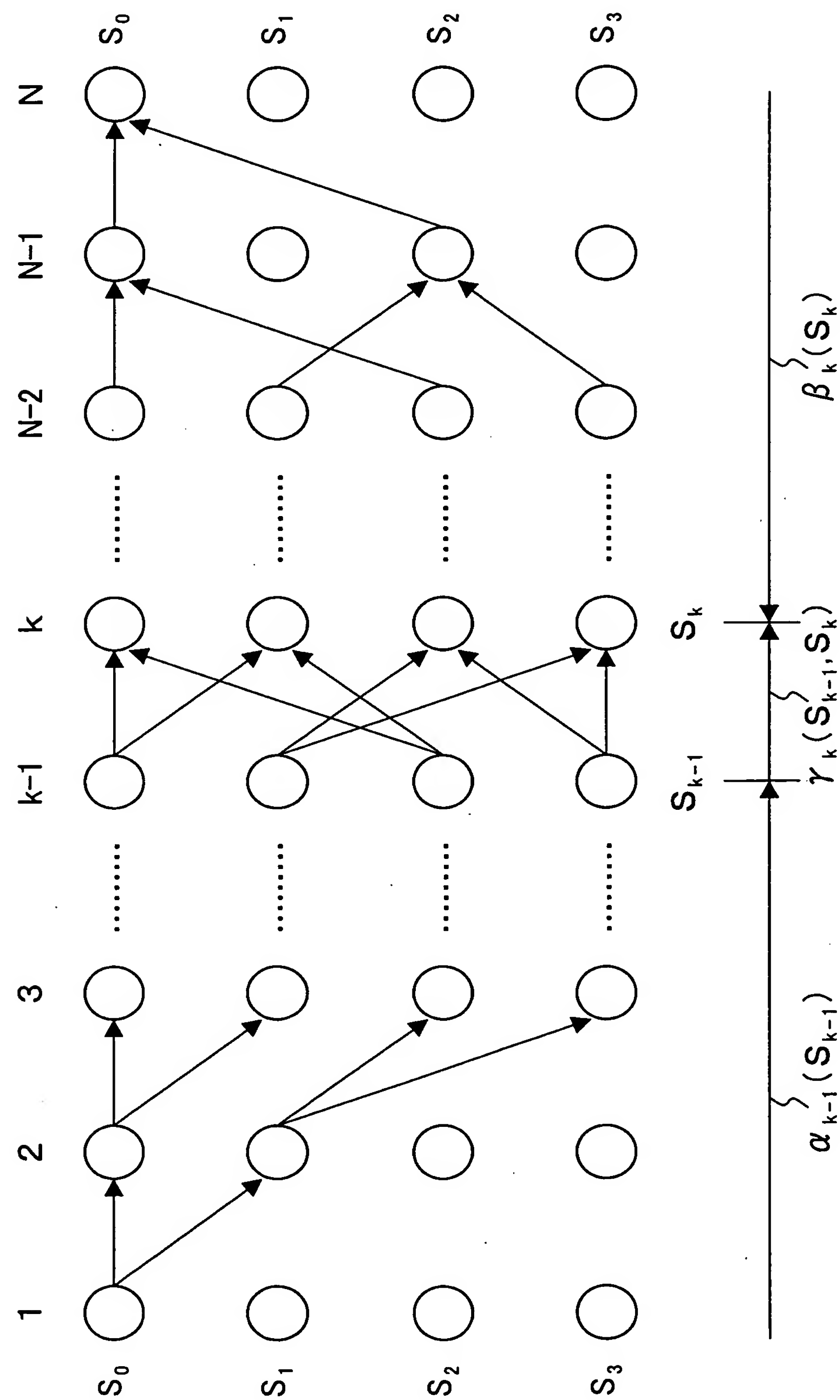

1
2
3
k-1
k
N-2
N-1
N
S_0
S_1
S_2
S_3
S_{k-1}
S_k
$\alpha_{k-1}(S_{k-1})$
$\gamma_k(S_{k-1},S_k)$
$\beta_k(S_k)$

FIG. 8

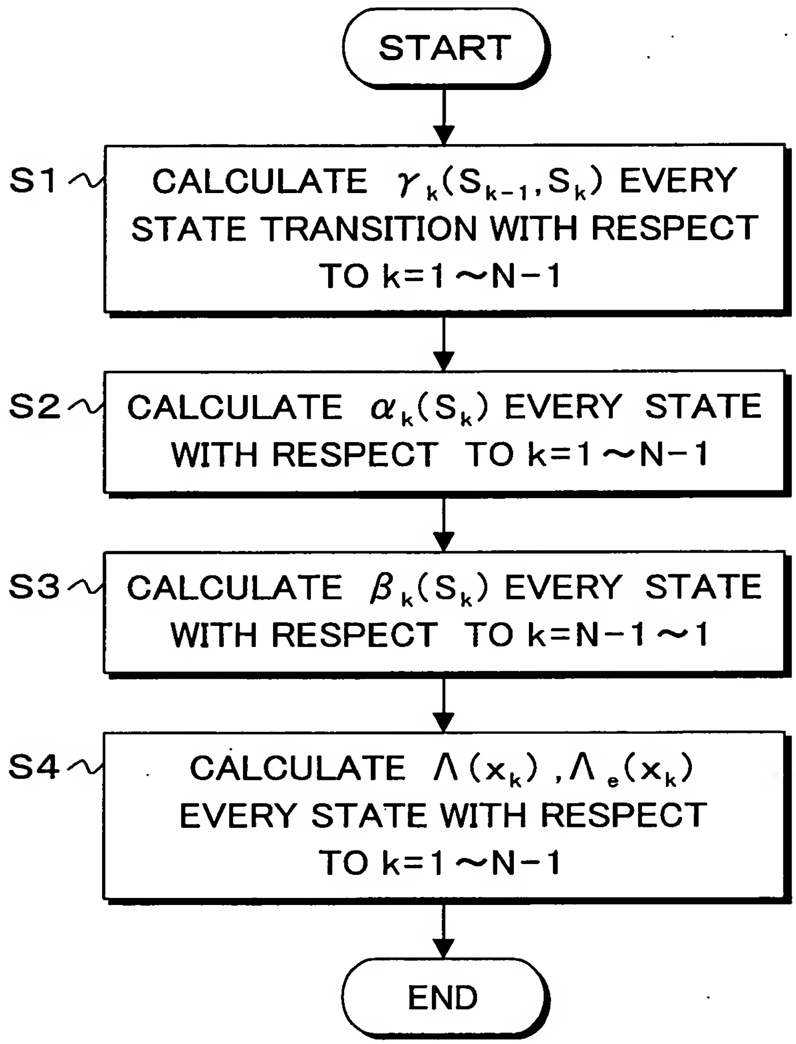

START
S1
CALCULATE $\gamma_k(S_{k-1}, S_k)$ EVERY STATE TRANSITION WITH RESPECT TO k=1 ~N−1
S2
CALCULATE $\alpha_k(S_k)$ EVERY STATE WITH RESPECT TO k=1 ~N−1
S3
CALCULATE $\beta_k(S_k)$ EVERY STATE WITH RESPECT TO k=N−1 ~1
S4
CALCULATE $\Lambda(x_k)$, $\Lambda_e(x_k)$ EVERY STATE WITH RESPECT TO k=1 ~N−1
END

FIG. 9

RECORDING SIGNAL x_k ON MEDIUM							STATE	MEAN VALUE OF WAVEFORM AFTER EQUALIZATION
x_{k-N}	…	x_{k-1}	x_k	x_{k+1}	…	x_{k+Q}		
0	…	0	0	0	…	0	S^m_0	$d(S^m_0)$
0	…	0	0	0	…	1	S^m_1	$d(S^m_1)$
…	…	…	…	…	…	…	……	……
1	…	1	1	1	…	0	$S^m_{2\hat{}[N+Q+1]-2}$	$d(S^m_{2\hat{}[N+Q+1]-2})$
1	…	1	1	1	…	1	$S^m_{2\hat{}[N+Q+1]-1}$	$d(S^m_{2\hat{}[N+Q+1]-1})$

FIG. 10A

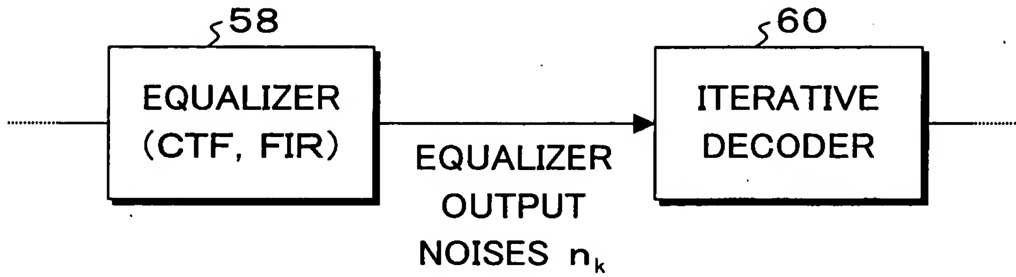


FIG. 10B

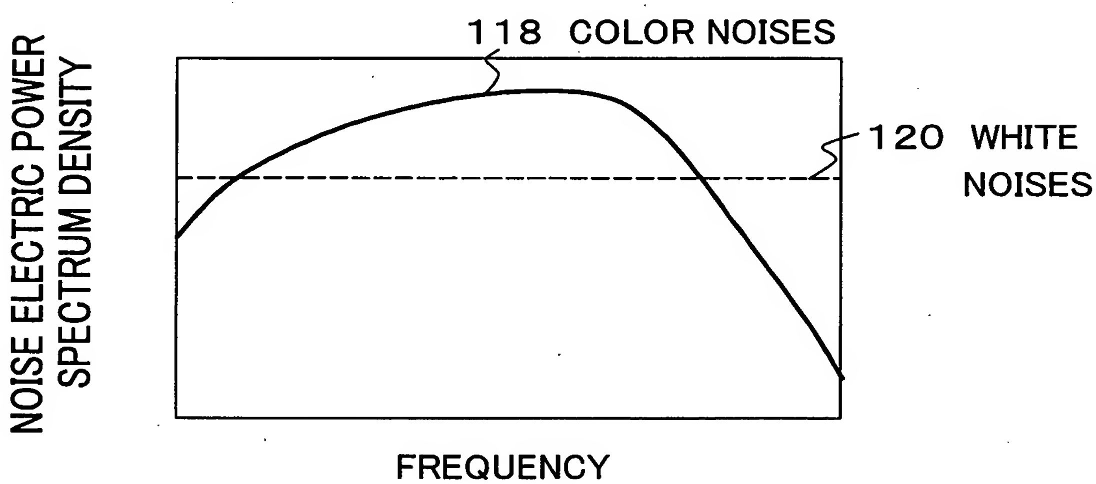


FIG. 10C

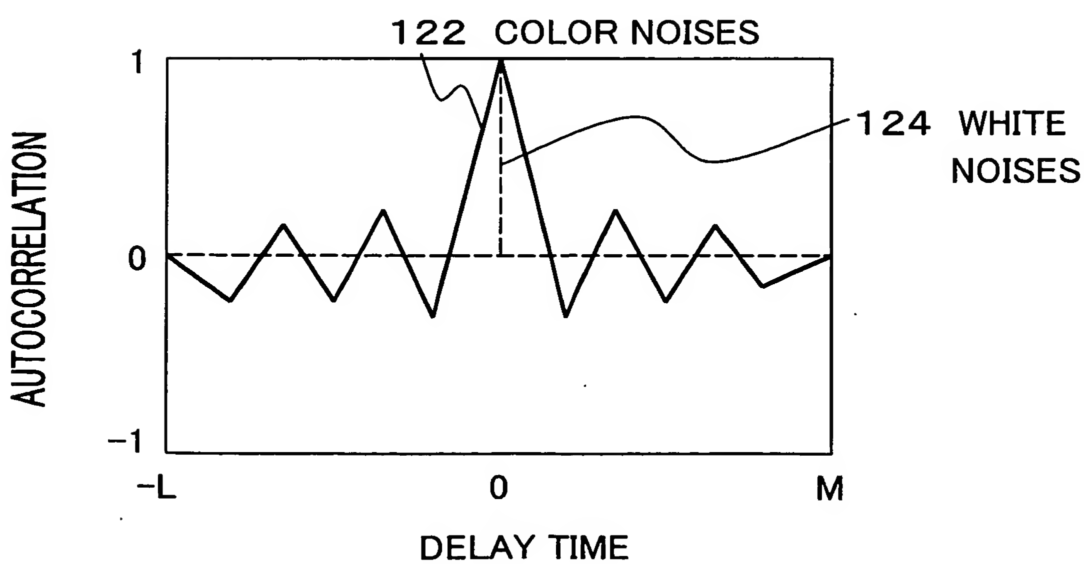
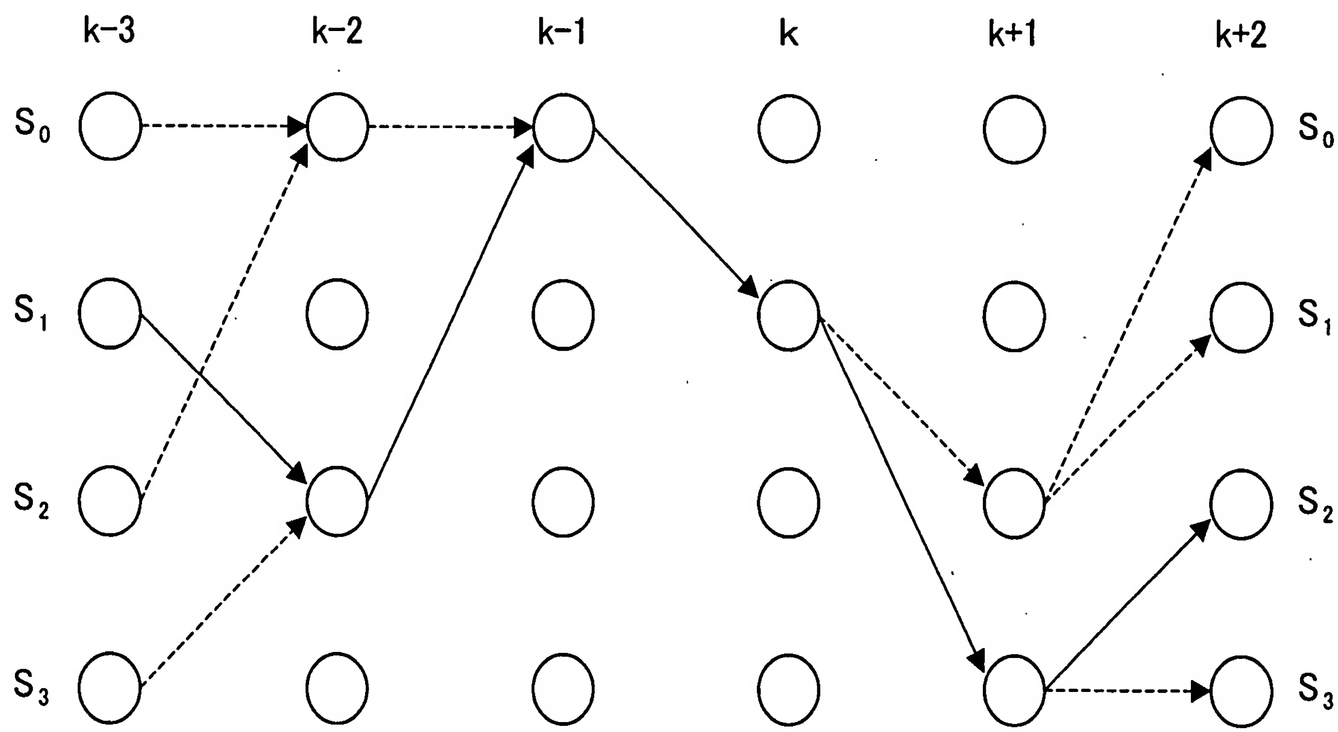


FIG. 11

STATE	CORRELATION OF NOISES						STANDARD DEVIATION OF NOISES $\sigma(S^m_k)$
	$e_{-L}(S^m_k)$	…	$e_{-1}(S^m_k)$	$e_1(S^m_k)$	…	$e_M(S^m_k)$	
S^m_0	$e_{-L}(S^m_0)$	…	$e_{-1}(S^m_0)$	$e_1(S^m_0)$	…	$e_M(S^m_0)$	$\sigma(S^m_0)$
S^m_1	$e_{-L}(S^m_1)$	…	$e_{-1}(S^m_1)$	$e_1(S^m_1)$	…	$e_M(S^m_1)$	$\sigma(S^m_1)$
……	……	…	……	……	…	……	……
$S^m_{2\hat{}[N+Q+1]-2}$	$e_{-L}(S^m_{2\hat{}[N+Q+1]-2})$	…	$e_{-1}(S^m_{2\hat{}[N+Q+1]-2})$	$e_1(S^m_{2\hat{}[N+Q+1]-2})$	…	$e_M(S^m_{2\hat{}[N+Q+1]-2})$	$\sigma(S^m_{2\hat{}[N+Q+1]-2})$
$S^m_{2\hat{}[N+Q+1]-1}$	$e_{-L}(S^m_{2\hat{}[N+Q+1]-1})$	…	$e_{-1}(S^m_{2\hat{}[N+Q+1]-1})$	$e_1(S^m_{2\hat{}[N+Q+1]-1})$	…	$e_M(S^m_{2\hat{}[N+Q+1]-1})$	$\sigma(S^m_{2\hat{}[N+Q+1]-1})$

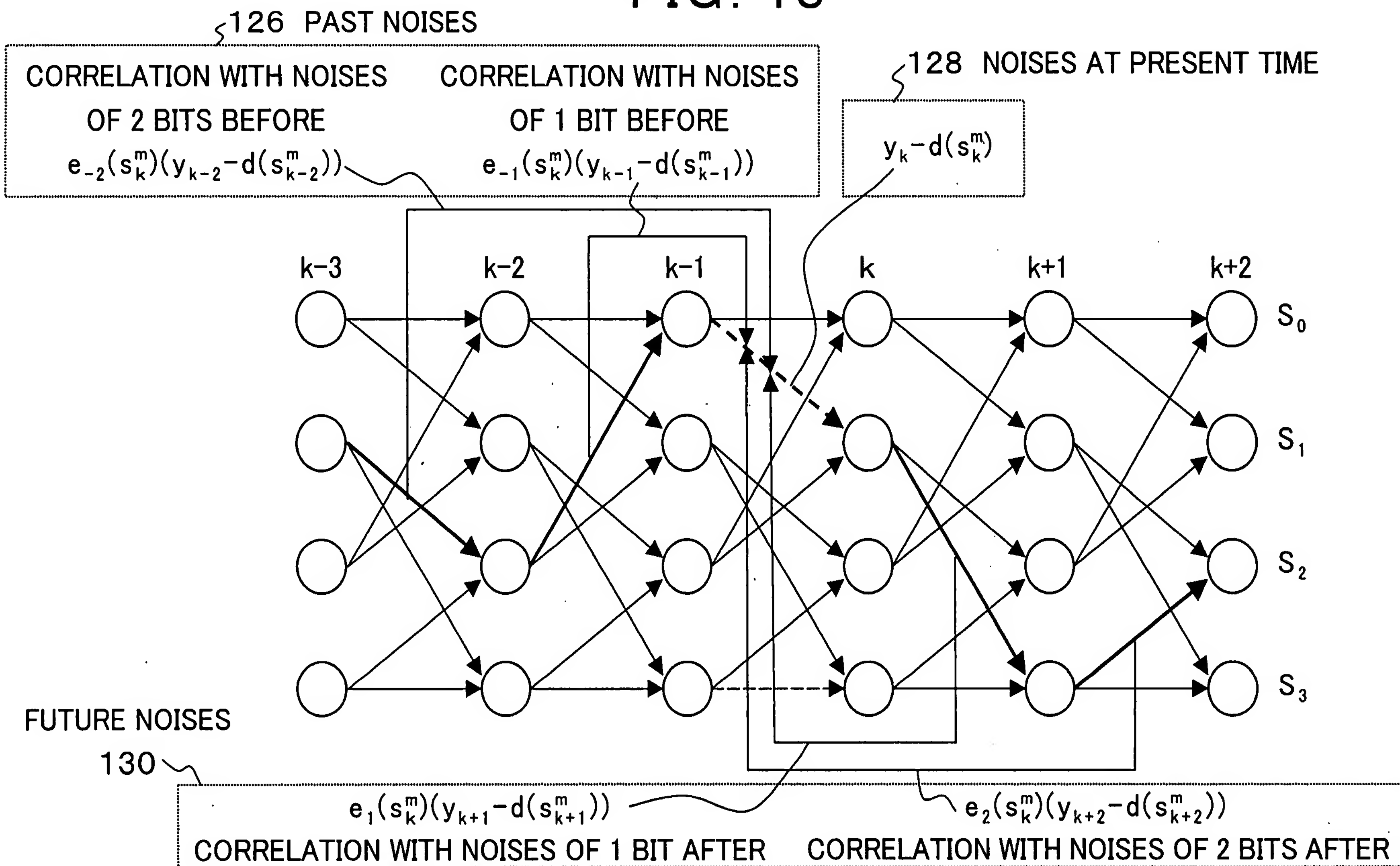
FIG. 12



$S_{k-1}=S_0$ → PATHS WHICH PASS $S_k=S_1$

$S_{k-1}=S_0$ → PATH OF THE SHORTEST PATH METRIC AMONG PATHS WHICH PASS $S_k=S_1$

FIG. 13



CHANNEL INFORMATION IN CASE OF REACHING s_k FROM s_{k-1}

$$\Lambda c(y_k|s_k^m) = -\ln\sigma(s_k^m) - \frac{(y_k-d(s_k^m)-e_{-1}(s_k^m)(y_{k-1}-d(s_{k-1}^m))-e_{-2}(s_k^m)(y_{k-2}-d(s_{k-2}^m))-e_1(s_k^m)(y_{k+1}-d(s_{k+1}^m))-e_2(s_k^m)(y_{k+2}-d(s_{k+2}^m)))^2}{2\sigma^2(s_k^m)}$$

FIG. 14

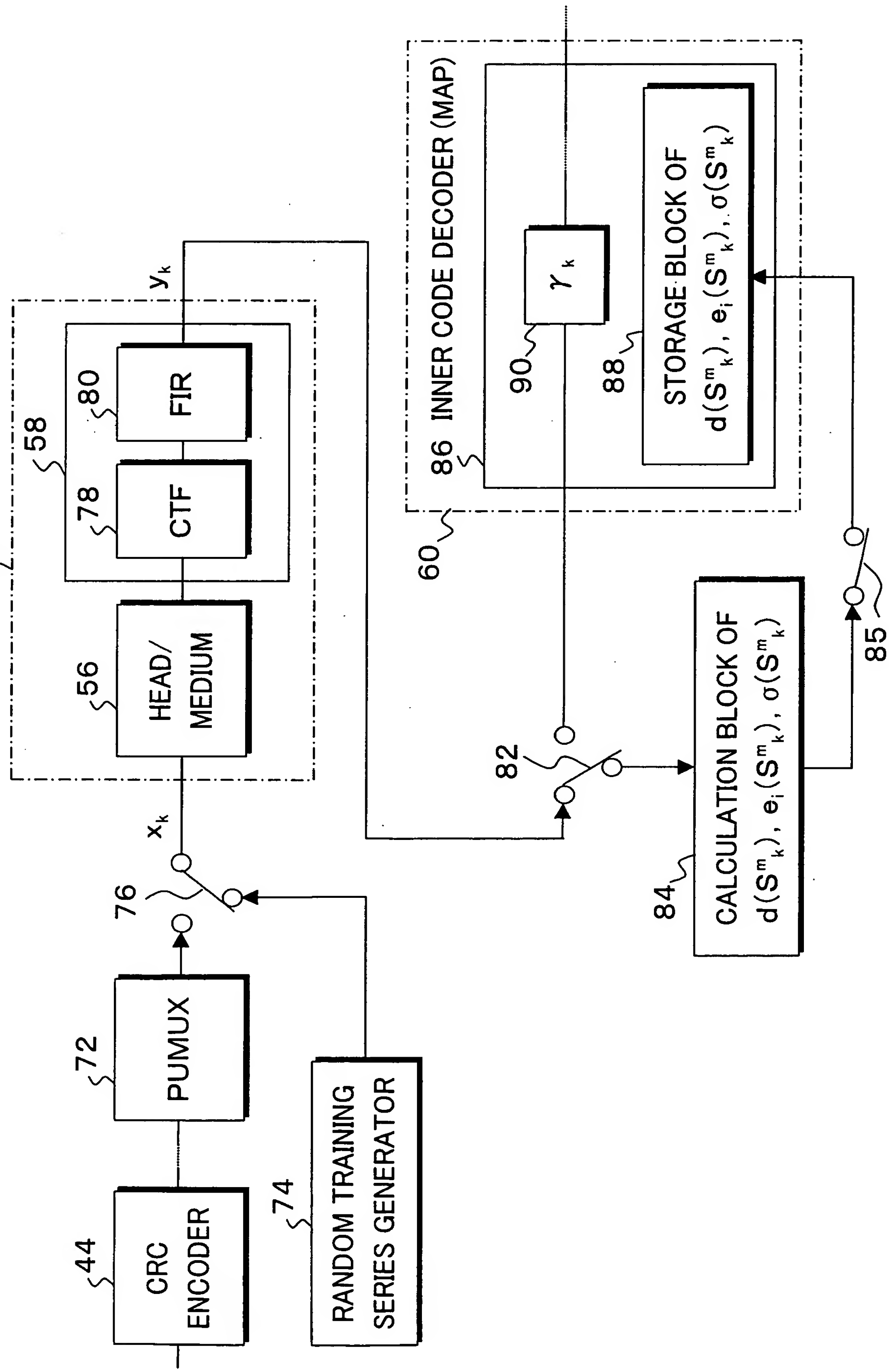

CRC ENCODER
44
PUMUX
72
RANDOM TRAINING SERIES GENERATOR
74
76
x_k
HEAD/ MEDIUM
56
CTF
78
FIR
80
58
54
y_k
82
CALCULATION BLOCK OF $d(S^m_k)$, $e_i(S^m_k)$, $\sigma(S^m_k)$
84
85
INNER CODE DECODER (MAP)
86
60
γ_k
90
STORAGE BLOCK OF $d(S^m_k)$, $e_i(S^m_k)$, $\sigma(S^m_k)$
88

FIG. 15

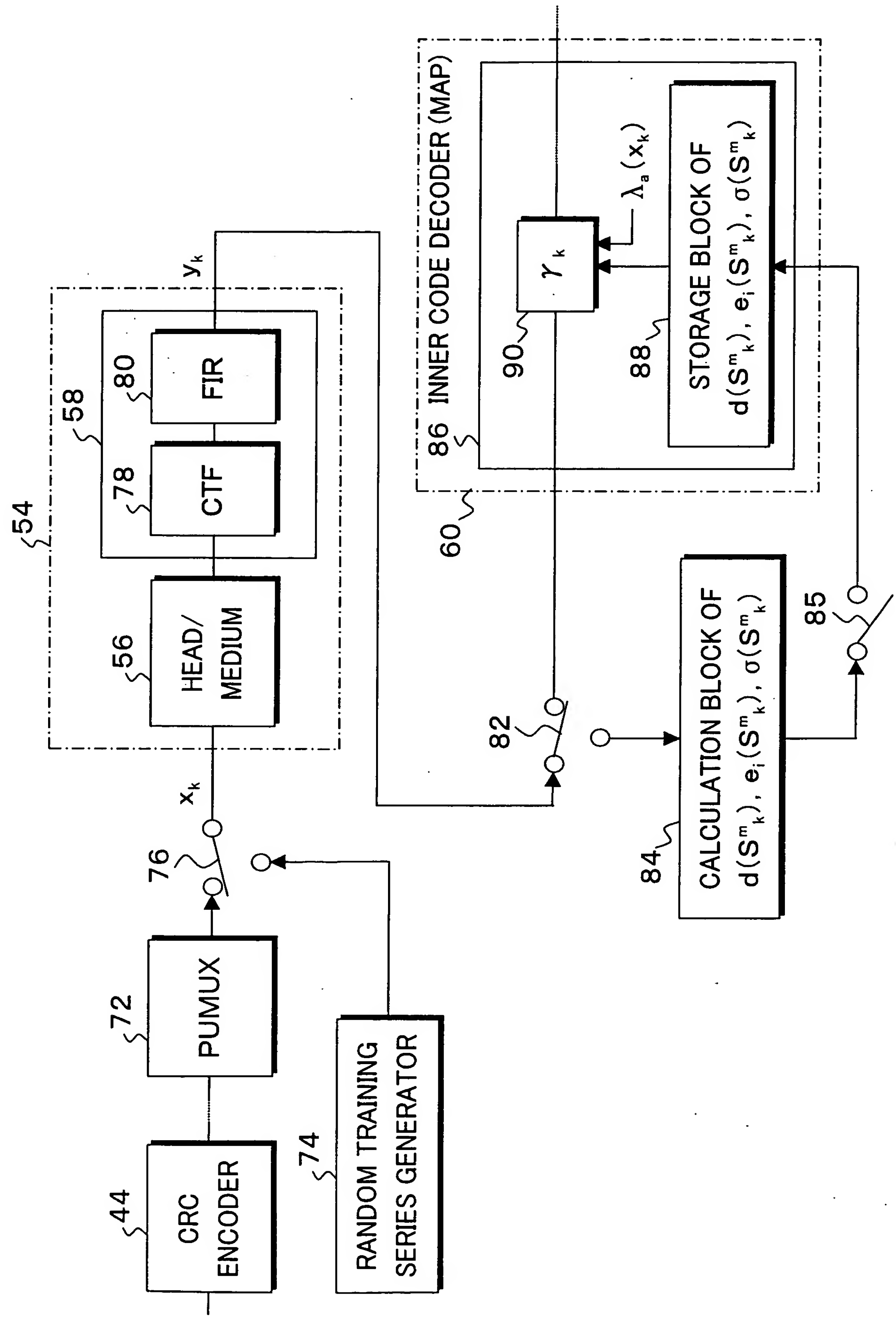

44
CRC ENCODER
72
PUMUX
74
RANDOM TRAINING SERIES GENERATOR
76
x_k
54
56
HEAD/ MEDIUM
58
78
CTF
80
FIR
y_k
82
84
CALCULATION BLOCK OF $d(S^m_k)$, $e_i(S^m_k)$, $\sigma(S^m_k)$
85
60
86 INNER CODE DECODER (MAP)
90
γ_k
$\lambda_a(x_k)$
88
STORAGE BLOCK OF $d(S^m_k)$, $e_i(S^m_k)$, $\sigma(S^m_k)$

FIG. 16

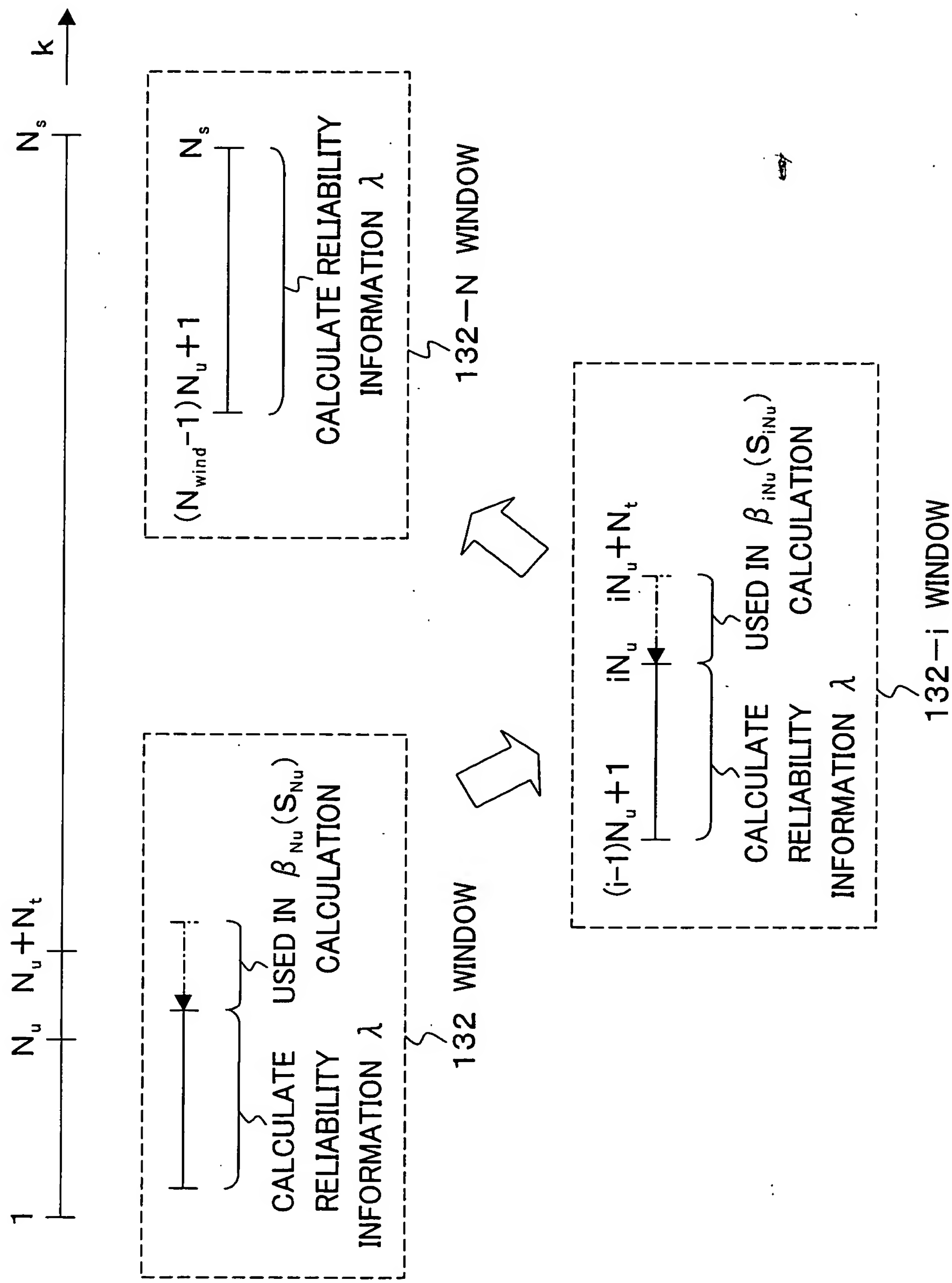

k
1
N_u
N_u+N_t
N_s
CALCULATE RELIABILITY INFORMATION λ
USED IN $\beta_{Nu}(S_{Nu})$ CALCULATION
132 WINDOW
$(i-1)N_u+1$
iN_u
iN_u+N_t
CALCULATE RELIABILITY INFORMATION λ
USED IN $\beta_{iNu}(S_{iNu})$ CALCULATION
132−i WINDOW
$(N_{wind}-1)N_u+1$
N_s
CALCULATE RELIABILITY INFORMATION λ
132−N WINDOW

FIG. 17A

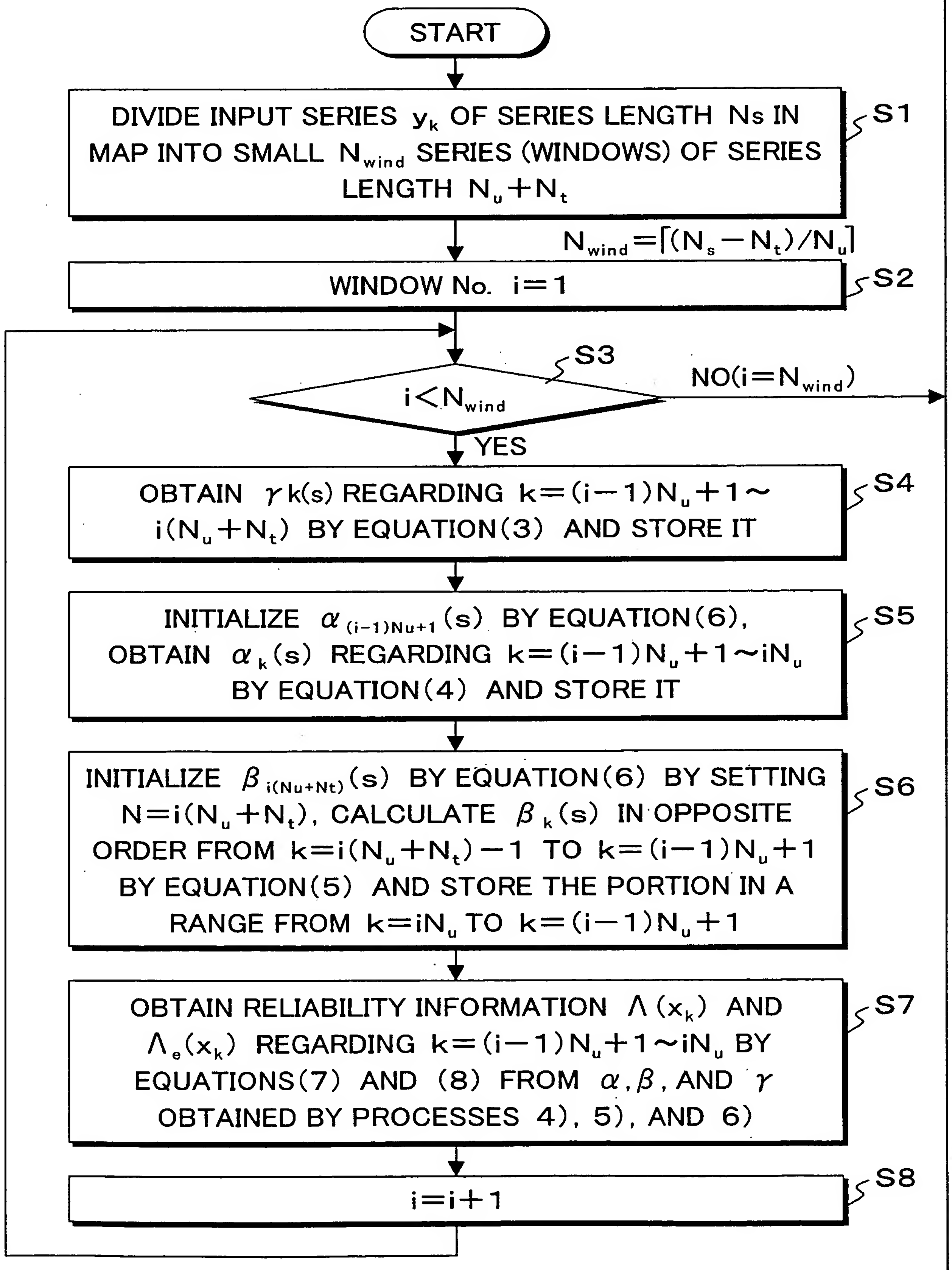

START
DIVIDE INPUT SERIES y_k OF SERIES LENGTH Ns IN MAP INTO SMALL N_{wind} SERIES (WINDOWS) OF SERIES LENGTH N_u+N_t
S1
$N_{wind}=\lceil(N_s-N_t)/N_u\rceil$
WINDOW No. i=1
S2
S3
$i<N_{wind}$
NO($i=N_{wind}$)
YES
OBTAIN $\gamma k(s)$ REGARDING $k=(i-1)N_u+1\sim i(N_u+N_t)$ BY EQUATION(3) AND STORE IT
S4
INITIALIZE $\alpha_{(i-1)Nu+1}(s)$ BY EQUATION(6), OBTAIN $\alpha_k(s)$ REGARDING $k=(i-1)N_u+1\sim iN_u$ BY EQUATION(4) AND STORE IT
S5
INITIALIZE $\beta_{i(Nu+Nt)}(s)$ BY EQUATION(6) BY SETTING $N=i(N_u+N_t)$, CALCULATE $\beta_k(s)$ IN OPPOSITE ORDER FROM $k=i(N_u+N_t)-1$ TO $k=(i-1)N_u+1$ BY EQUATION(5) AND STORE THE PORTION IN A RANGE FROM $k=iN_u$ TO $k=(i-1)N_u+1$
S6
OBTAIN RELIABILITY INFORMATION $\Lambda(x_k)$ AND $\Lambda_e(x_k)$ REGARDING $k=(i-1)N_u+1\sim iN_u$ BY EQUATIONS(7) AND (8) FROM α,β, AND γ OBTAINED BY PROCESSES 4), 5), AND 6)
S7
$i=i+1$
S8

FIG. 17B

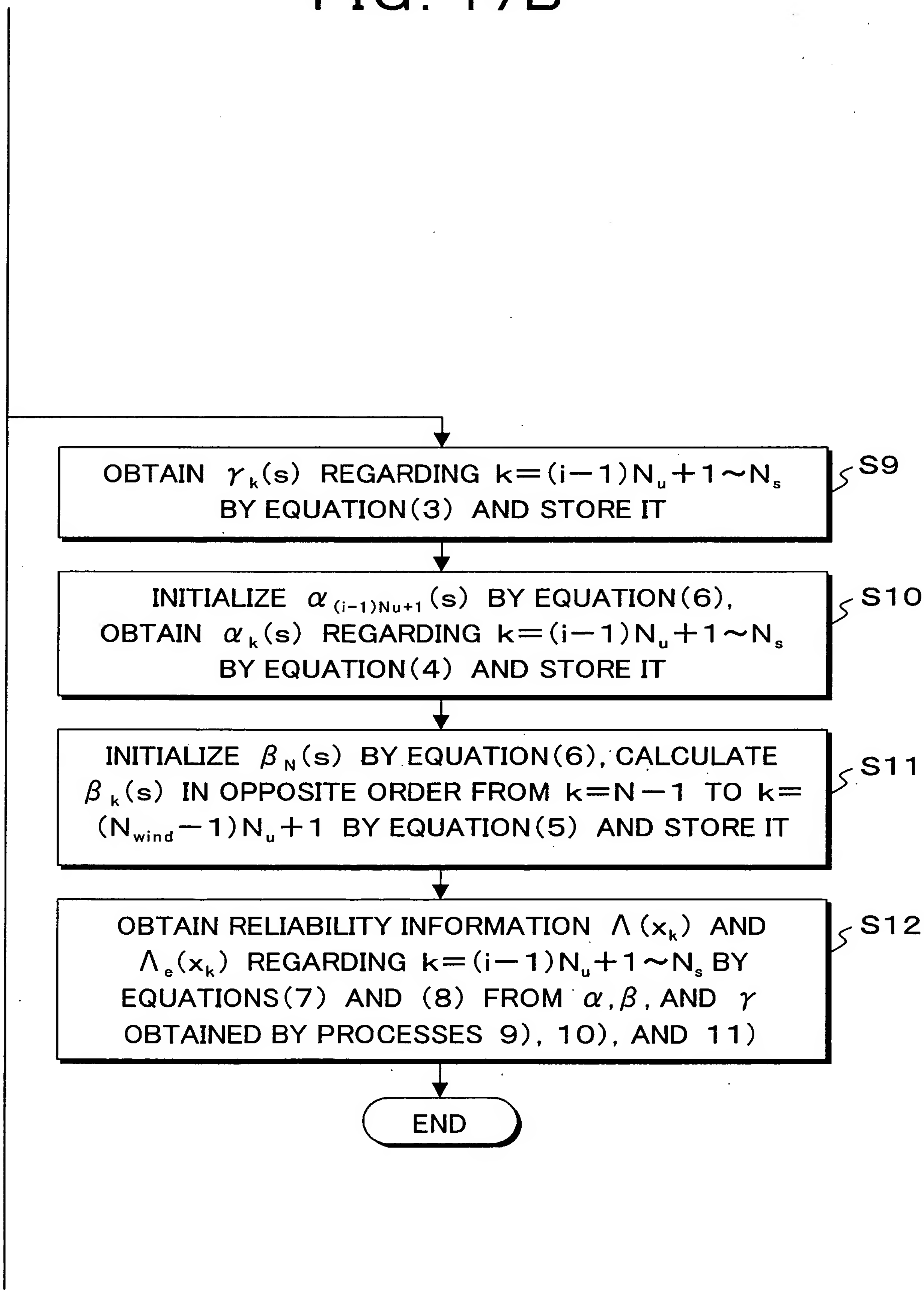

OBTAIN $\gamma_k(s)$ REGARDING $k=(i-1)N_u+1 \sim N_s$ BY EQUATION (3) AND STORE IT
S9
INITIALIZE $\alpha_{(i-1)Nu+1}(s)$ BY EQUATION (6), OBTAIN $\alpha_k(s)$ REGARDING $k=(i-1)N_u+1 \sim N_s$ BY EQUATION (4) AND STORE IT
S10
INITIALIZE $\beta_N(s)$ BY EQUATION (6), CALCULATE $\beta_k(s)$ IN OPPOSITE ORDER FROM $k=N-1$ TO $k=(N_{wind}-1)N_u+1$ BY EQUATION (5) AND STORE IT
S11
OBTAIN RELIABILITY INFORMATION $\Lambda(x_k)$ AND $\Lambda_e(x_k)$ REGARDING $k=(i-1)N_u+1 \sim N_s$ BY EQUATIONS (7) AND (8) FROM α, β, AND γ OBTAINED BY PROCESSES 9), 10), AND 11)
S12
END

FIG. 18

$x_{k-3}x_{k-2}x_{k-1}x_k$	STATE
0000	$S^m{}_0$
0001	$S^m{}_1$
0010	$S^m{}_2$
0011	$S^m{}_3$
0100	$S^m{}_4$
0101	NOT EXIST
0110	$S^m{}_6$
0111	$S^m{}_7$
1000	$S^m{}_8$
1001	$S^m{}_9$
1010	NOT EXIST
1011	$S^m{}_{11}$
1100	$S^m{}_{12}$
1101	$S^m{}_{13}$
1110	$S^m{}_{14}$
1111	$S^m{}_{15}$

FIG. 19

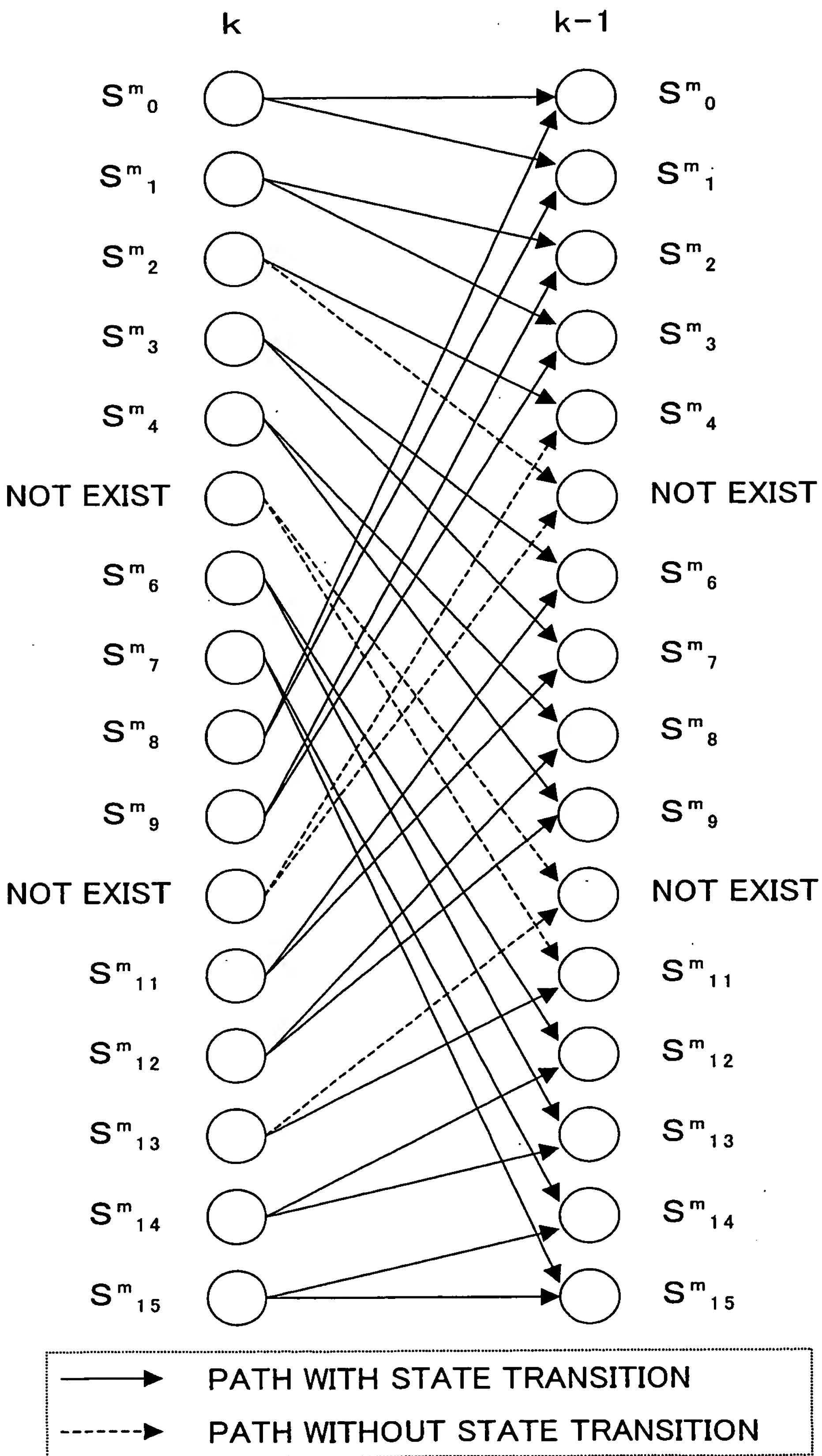

k
k-1
S^m_0
S^m_1
S^m_2
S^m_3
S^m_4
NOT EXIST
S^m_6
S^m_7
S^m_8
S^m_9
NOT EXIST
S^m_{11}
S^m_{12}
S^m_{13}
S^m_{14}
S^m_{15}
PATH WITH STATE TRANSITION
PATH WITHOUT STATE TRANSITION

FIG. 20

STATE	CORRELATION OF NOISES						STANDARD DEVIATION OF NOISES	MEAN VALUE OF EQUALIZATION SIGNAL
	$e_{-L}(S^m_k)$	⋯	$e_{-1}(S^m_k)$	$e_1(S^m_k)$	⋯	$e_M(S^m_k)$	$\sigma(S^m_k)$	$d(S^m_k)$
S^m_0	$e_{-L}(S^m_0)$	⋯	$e_{-1}(S^m_0)$	$e_1(S^m_0)$	⋯	$e_M(S^m_0)$	$\sigma(S^m_0)$	$d(S^m_0)$
S^m_1	$e_{-L}(S^m_1)$	⋯	$e_{-1}(S^m_1)$	$e_1(S^m_1)$	⋯	$e_M(S^m_1)$	$\sigma(S^m_1)$	$d(S^m_1)$
S^m_2	$e_{-L}(S^m_2)$	⋯	$e_{-1}(S^m_2)$	$e_1(S^m_2)$	⋯	$e_M(S^m_2)$	$\sigma(S^m_2)$	$d(S^m_2)$
S^m_3	$e_{-L}(S^m_3)$	⋯	$e_{-1}(S^m_3)$	$e_1(S^m_3)$	⋯	$e_M(S^m_3)$	$\sigma(S^m_3)$	$d(S^m_3)$
S^m_4	$e_{-L}(S^m_4)$	⋯	$e_{-1}(S^m_4)$	$e_1(S^m_4)$	⋯	$e_M(S^m_4)$	$\sigma(S^m_4)$	$d(S^m_4)$
NOT EXIST	—	⋯	—	—	⋯	—	—	—
S^m_6	$e_{-L}(S^m_6)$	⋯	$e_{-1}(S^m_6)$	$e_1(S^m_6)$	⋯	$e_M(S^m_6)$	$\sigma(S^m_6)$	$d(S^m_6)$
S^m_7	$e_{-L}(S^m_7)$	⋯	$e_{-1}(S^m_7)$	$e_1(S^m_7)$	⋯	$e_M(S^m_7)$	$\sigma(S^m_7)$	$d(S^m_7)$
S^m_8	$e_{-L}(S^m_8)$	⋯	$e_{-1}(S^m_8)$	$e_1(S^m_8)$	⋯	$e_M(S^m_8)$	$\sigma(S^m_8)$	$d(S^m_8)$
S^m_9	$e_{-L}(S^m_9)$	⋯	$e_{-1}(S^m_9)$	$e_1(S^m_9)$	⋯	$e_M(S^m_9)$	$\sigma(S^m_9)$	$d(S^m_9)$
NOT EXIST	—	⋯	—	—	⋯	—	—	—
S^m_{11}	$e_{-L}(S^m_{11})$	⋯	$e_{-1}(S^m_{11})$	$e_1(S^m_{11})$	⋯	$e_M(S^m_{11})$	$\sigma(S^m_{11})$	$d(S^m_{11})$
S^m_{12}	$e_{-L}(S^m_{12})$	⋯	$e_{-1}(S^m_{12})$	$e_1(S^m_{12})$	⋯	$e_M(S^m_{12})$	$\sigma(S^m_{12})$	$d(S^m_{12})$
S^m_{13}	$e_{-L}(S^m_{13})$	⋯	$e_{-1}(S^m_{13})$	$e_1(S^m_{13})$	⋯	$e_M(S^m_{13})$	$\sigma(S^m_{13})$	$d(S^m_{13})$
S^m_{14}	$e_{-L}(S^m_{14})$	⋯	$e_{-1}(S^m_{14})$	$e_1(S^m_{14})$	⋯	$e_M(S^m_{14})$	$\sigma(S^m_{14})$	$d(S^m_{14})$
S^m_{15}	$e_{-L}(S^m_{15})$	⋯	$e_{-1}(S^m_{15})$	$e_1(S^m_{15})$	⋯	$e_M(S^m_{15})$	$\sigma(S^m_{15})$	$d(S^m_{15})$